



Electronics Division
Joplin, MO

ADVANCED SYSTEMS OPERATION

1991 NASA AEROSPACE BATTERY WORKSHOP

Use of Semi-Automated Test Systems for Nickel-Hydrogen Cells and Batteries

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Joplin, Missouri



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NICKEL-HYDROGEN TESTING AT EPI

- * TEN CELL TEST SYSTEMS -- 1000 CELLS
- * FOUR BATTERY TEST SYSTEMS -- 15 BATTERIES
- * AN ADDITIONAL TWO-BATTERY SYSTEM IS BEING BUILT
- * MULTIPLE LIFE TESTS AND SPECIAL TEST EQUIPMENT
- * LONGEST LIFE TEST IS NOW OVER SIX YEARS
- * ALL SYSTEM HARDWARE AND SOFTWARE ARE DESIGNED,
BUILT, MAINTAINED BY IN-HOUSE PERSONNEL
- * ALL TEMPERATURE CONTROL SYSTEMS FOR PRODUCTION
TESTING ARE BUILT IN-HOUSE



TEST DATA

- * REAL TIME GRAPHICS
- * THIRTY MINUTE HISTORICAL PLOTS DURING TEST
- * DATA OUTPUT ON DISK AND PAPER
- * EVENT SUMMARY
 - * AMPHOURS
 - * WATTHOURS
 - * MAX/MIN VOLTAGE VS. TIME
 - * VOLTAGE AND TEMPERATURE VS. TIME PLOTS
 - * LIST OF EXCEPTIONS



1991 NASA AEROSPACE BATTERY WORKSHOP

OUTPUT TIME: 10:23:51 18 Oct 1991

Cell: RNN-XX-X Documents: Lat No: XX Job No: XXXX Software Revision:
Paragraph: 14.2.3
TEST EVENT 7 Charge at 9.3 Amps for 12 Hours
EVENT START 00:21:11 18 Oct 1991 ELAPSED TIME 02:01:20

EVENT 7		Charges at 9.3 Hours for 12 Hours		TIME 02-01-20	
THERMOCOUPLE DATA: Temp Specified = 20.00 12.6 deg					
Left Cart	Pos: 19.94	Min: 19.54	(# T/Cs 5)	Max: 20.36	(# T/Cs 3)
Right Cart	Pos: 20.04	Min: 19.09	(# T/Cs 10)	Max: 20.36	(# T/Cs 11)

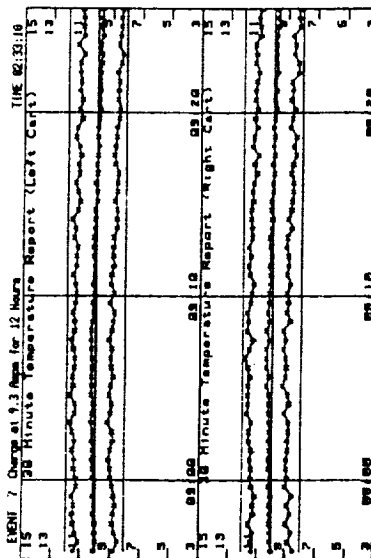


Left current = 9.24 Amps.
Right current = 9.38 Amps.

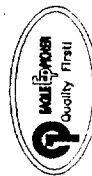
SAMPLE REAL TIME GRAPHICS

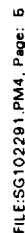
OUTPUT TIME:09:26:26 15 Oct 1991

Cells: RNM-XX-X
Documents:
Lot No: XX Job No: XXXX
Paragraphs 14.2.3
TEST EVENT 7 Charge at 9.3 Amps for 12 Hours
Software Revisions: 6.4



SAMPLE HISTORICAL PLOT





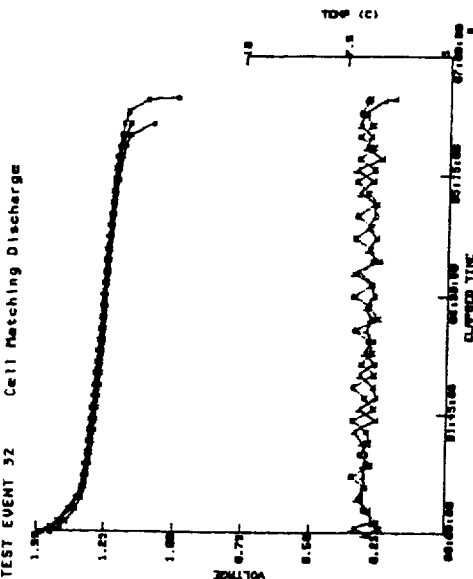
1991 NASA AEROSPACE BATTERY WORKSHOP

Activation and Conditioning / Cell Selection
Cells: RNI-XX-X
Document: EP-92-XXX Rev X
lot No: 14
Paragraph: 5.2.2
TEST EVENT 32 Cell Matching Discharge
Time to bypass at 1,000 volt

Software Revision: 6.4

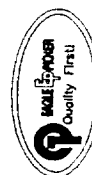
Motivation and Conditioning / Cell Selection
 Call: RNH-XX-X
 Document: EP-PP-XXX Rev X
 Lot No: 14
 Paragraph: 5.2.2
 TEST EVENT 32 Cell Matching Discharge

Software Revision: 6.4



No	Elapsed	Description	Elapsed Time
1	00:25:20	Alert due to BIPASS FAILURE. Open circuit for 00:04:50	
2	00:31:50	Test restart at 20 Sep 1991 07:30:00. System down for 00:00:18	
3	01:28:40	Operator pause. Open circuit for 00:01:50	
4	01:35:10	Interruption for TC BYPASS. Open circuit for 00:00:45	

Event start:	06:27:51	20 Sep 1991	
Event stop:	12:57:35	20 Sep 1991	
Event duration:	06:29:44	Load duration:	06:22:00 Difference: 00:07:44



SAMPLE SUMMARY SHEETS

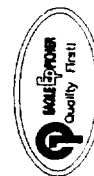
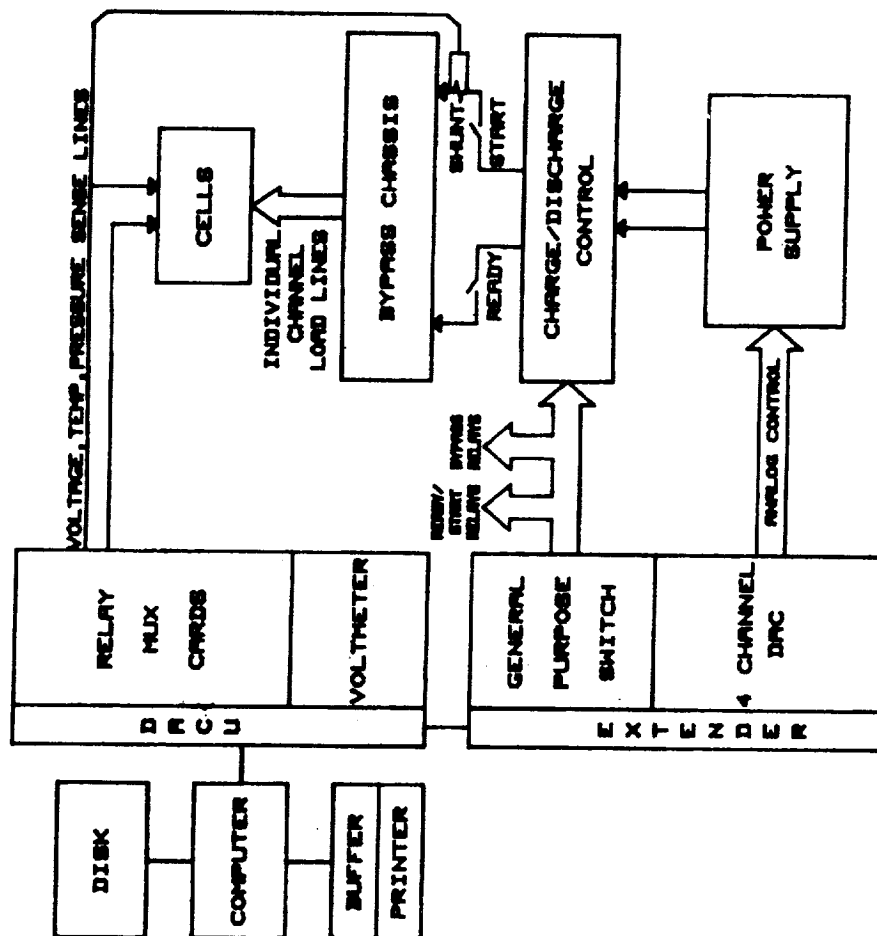
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STANDARD CELL LEVEL TESTING

- * MONITORING CAPABILITY - 120 CELL VOLTAGES
 - * 20 THERMOCOUPLES
- * CHARGE CAPABILITY - 0 TO 125 AMPS
- * DISCHARGE CAPABILITY - 15 TO 125 AMPS CONTINUOUS
 - * 125 TO 180 AMP PULSES (10 SECONDS TO 5 MINUTES)
- * BYPASS CAPABILITY - INDIVIDUAL CELLS
- * TEST SYSTEM CONFIGURATION:
 - * HEWLETT PACKARD 310 COMPUTER
 - * HEWLETT PACKARD 9153C 10Mb HARD DISK W/3.5" FLOPPY
 - * HEWLETT PACKARD 2934A PRINTER W/ INTELLIGENT INTER-FACES BUFFER
 - * HEWLETT PACKARD 3852A DATA ACQUISITION AND CONTROL UNIT
 - * HEWLETT PACKARD 3853A DACU EXTENDER
 - * ELECTRONIC MEASUREMENT INCORPORATED EMHP-150-200 POWER SUPPLY



STANDARD CELL LEVEL TEST SYSTEM

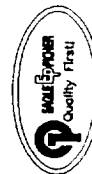
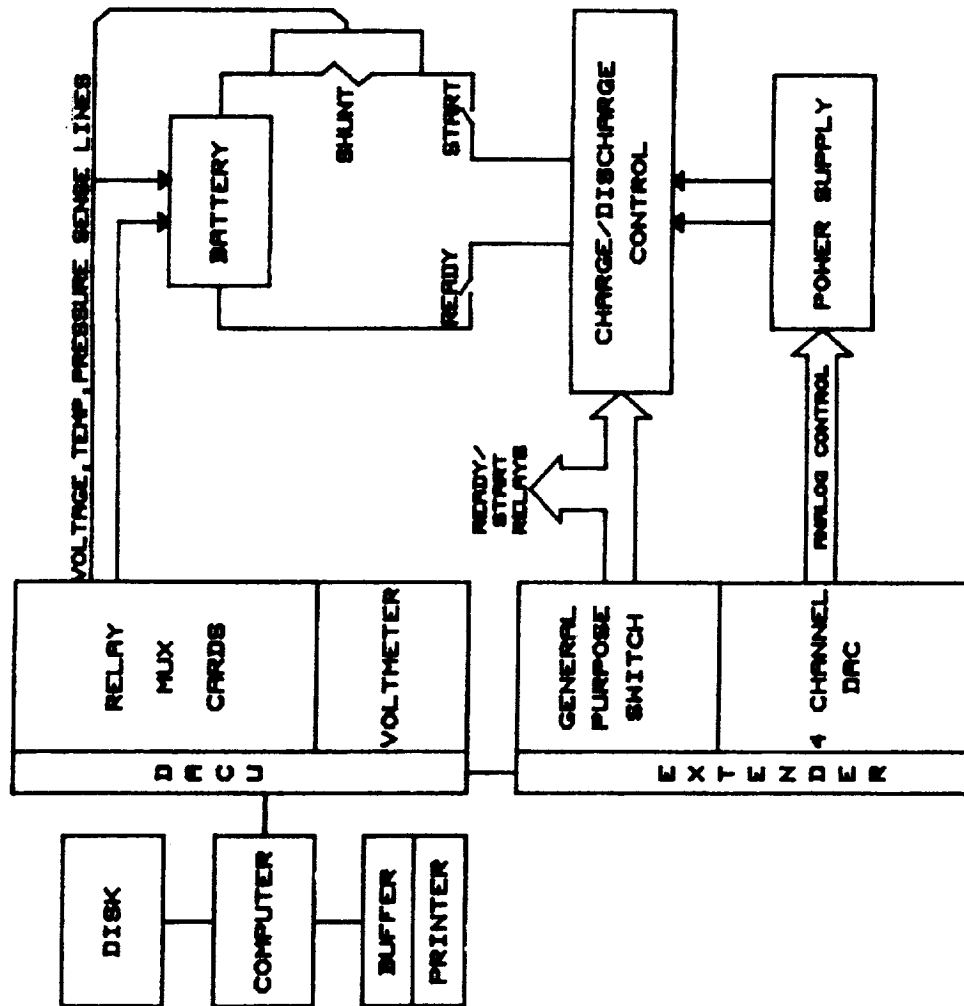


STANDARD BATTERY LEVEL TESTING

- * MONITORING CAPABILITY - 31 CELL VOLTAGES PER BATTERY
 - * 10 THERMOCOUPLES PER BATTERY
 - * 12 ADDITIONAL VOLTAGE CHANNELS PER BATTERY
- * CHARGE CAPABILITY - 0 TO 125 AMPS
- * DISCHARGE CAPABILITY - 5 TO 125 AMPS CONTINUOUS
 - * 125 TO 180 AMP PULSES (10 SECONDS TO 5 MINUTES)
- * TEST SYSTEM CONFIGURATION:
 - * HEWLETT PACKARD 300 SERIES COMPUTER
 - * HEWLETT PACKARD 9153C 10Mb HARD DISK W/3.5" FLOPPY
 - * HEWLETT PACKARD 2934A PRINTER W/ INTELLIGENT INTER-FACES BUFFER
 - * HEWLETT PACKARD 3852A DATA ACQUISITION AND CONTROL UNIT
 - * HEWLETT PACKARD 3853A DACU EXTENDER
 - * ELECTRONIC MEASUREMENT INCORPORATED EMHP-80-250 POWER SUPPLY

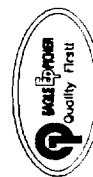


STANDARD BATTERY LEVEL TEST SYSTEM

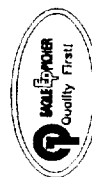


FEATURES

- * DESIGNED WITH OPERATOR INTERACTION FOR SAFETY
- * TEST DEFINITION SHEETS
- * AUTOMATIC CURRENT AND TEMPERATURE CONTROL
- * AC AND DC POWER CIRCUIT BREAKERS
- * DC VOLTAGE AND CURRENT LIMITS
- * CHARGE/DISCHARGE CIRCUIT DIODE PROTECTION
- * COMPUTER GUARD
- * DATA DISKS IN DIFFERENT FORMATS



SAMPLE TEST DEFINITION SHEETS



Sample Procedure File

Program: ATPXXX

Document: ATP-XXX Rev X

Record	Event	Description
1	1	Stabilization at 10C
2	2	Start of Cycle 1 (from 1 to max. of 20)
3	3	Charge at 3 Amps for 17 Hours
4	4	Discharge at 36 Amps (V/Pulse) to 0.5 Volts
5	5	Drain Cells to 0.1 V/Cell
6	6	Open Circuit for Decision to Continue Cycles
7	7	End of Cycle
8	8	Charge at 4 Amps for 36 Hours
9	9	Discharge at 36 A to 0.5 V/Cell
10	10	Drain Cells to 0.1 V/Cell
11	11	Open Circuit for Test Verification
12	12	End of Test

Sample Procedure File

Program: ATPXXX

Document: ATP-XXX Rev X Paragraph: 14.2.2

Events 2 (Charge) Charge at 9.3 Amps for 12 Hours

	Nominal	Abert	Wern 1	Wern 2
Temperature:	10.0	± 10.0	± 2.0	± 3.0
				(Degrees C)

Time	Volts
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
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96	96
97	97
98	98
99	99
100	100

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Current : 9.30 ±0.4.

Print-outs : 5 Minute mark

Intervals of 00:
Operator command

Maximum voltage and time of series

Sample Procedure File

Program: ATPXXX

Document: ATP-XXX Rev X Paragraph: 14.2.3

Event: 3 (Discharge) Discharge at 36 Amps (W/Pulse) to 0.5 Volts

Temperature	Nominal	Abort	Warn 1	Warn 2
(Degrees C)	10.0	±10.0	± 2.0	± 3.0

Time	Volts
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
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94	94
95	95
96	96
97	97
98	98
99	99
100	100

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Current	Nominal	Abert	Wern
	=	36.00	±18.00 ±0.100

01:30:10 :	85.00	±42.50	±0.100
01:30:40 :	36.00	±18.00	±0.100

Project	Start Date	End Date	Duration
Project A	01/01/2020	01/01/2021	365 days
Project B	02/01/2020	02/01/2021	365 days
Project C	03/01/2020	03/01/2021	365 days
Project D	04/01/2020	04/01/2021	365 days
Project E	05/01/2020	05/01/2021	365 days
Project F	06/01/2020	06/01/2021	365 days
Project G	07/01/2020	07/01/2021	365 days
Project H	08/01/2020	08/01/2021	365 days
Project I	09/01/2020	09/01/2021	365 days
Project J	10/01/2020	10/01/2021	365 days
Project K	11/01/2020	11/01/2021	365 days
Project L	12/01/2020	12/01/2021	365 days

30 Minute intervals till .85% of capacity

00:26:00	00:27:00
01:30:10	01:30:20

01:30:40

Termination

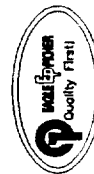
Time to	.300 volts
Time to	.900 volts

Time to 1,000 volts
Time to 1,200 volts

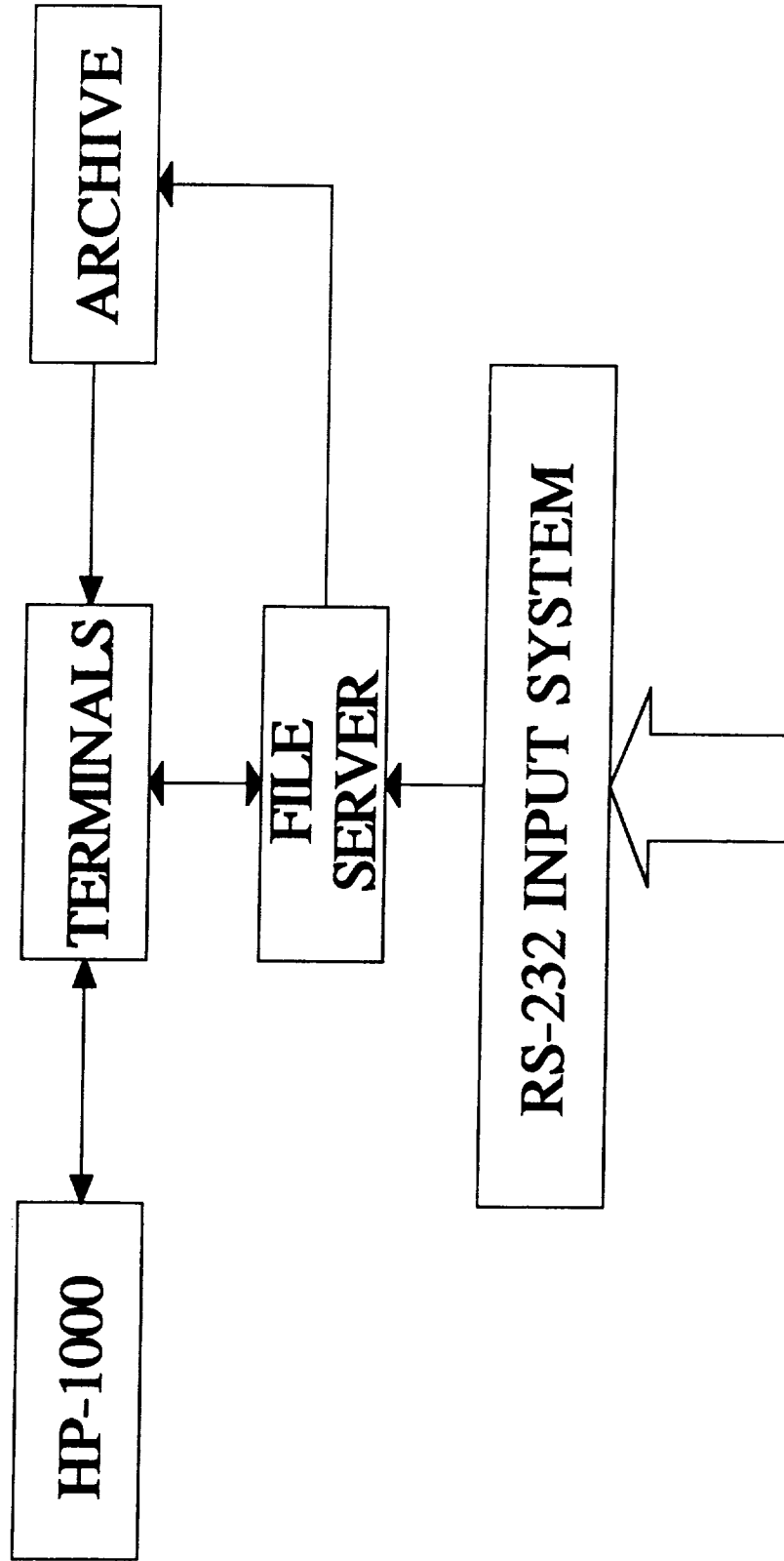
Table 1

SPECIAL TESTING

- * HIGHER OR LOWER CURRENT RATES
- * CONSTANT VOLTAGE CHARGES
- * CONSTANT POWER DISCHARGES
- * TEMPERATURE RAMPS
- * HIGH SPEED PULSES AND DATA ACQUISITION
- * DISCHARGE PULSES DURING CHARGES AND/OR DISCHARGES
- * TERMINATION AT DESIGNATED AMPHOURS OR PRESSURE
- * RECHARGE TO A PRESELECTED CHARGE/DISCHARGE RATIO



FUTURE DATA NETWORK



TEST SYSTEMS

